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# Extension of Single-sex Public School Provision: Evidential Concerns

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This is a preliminary report on an aspect of single-sex education in British secondary schools. It is based on a reanalysis of data on students' performance in mathematics in the General Certificate of Secondary Education (GCSE) in 2001. Students' attitudes to mathematics were also investigated. Girls' achievement within girls' schools was slightly higher than for girls in mixed schools, after adjustment for a range of factors. On average, the difference was about one tenth of a standard deviation. Boys, on average, performed less well in boys' schools than in mixed schools by about the same amount. In terms of girls' attitudes to mathematics, attendance at a girls' school was associated with more positive attitudes, again by about a tenth of a standard deviation. Boys' attitudes to mathematics were not significantly different between those attending boys' schools and those in mixed schools, however.

**Keywords:** single-sex schooling, school effectiveness, mathematics achievement, attitudes

Single-sex schools are popularly viewed as advantaging girls and coeducational schools as advantaging boys. The research literature, however, provides a much less clear picture of the relationship between single-sex education and student performance. The position reflects the scarcity of studies with adequate controls for pre-existing intake differences.

Coleman's (1961: 51) classic study of US adolescent subculture noted that coeducation might have damaging consequences: 'co-education in some high schools may be inimical to both academic achievement and social adjustment'.

Lee and Bryk (1986) concluded their analysis of US Catholic schools' data from the *High School and Beyond* survey by claiming that students, especially girls, benefited academically and attitudinally from single-sex schooling. Marsh (1989) reanalysed the data used by Lee and Bryk and challenged their findings on grounds of inadequate intake adjustment. In an Australian study by Marsh *et al.* (1989), which examined the transition of students from two single-sex schools to two coeducational schools within the same catchment area, transition-related achievement differences were not found. Surprisingly, perhaps, the teachers perceived the transition as contributing to improved performance for both boys and girls, a position not supported by the research evidence.

LePore and Warren (1996) were rather sceptical about the alleged advantages of single-sex Catholic schools, using NELS data, considering selection effects as a possible explanation for their apparent success. Adequately controlling for pre-existing differences is a long-standing problem in this research field (Daly, 1996; Marsh, 1989). Riordan's (2000) review of research on private single-sex schools in the USA concluded, somewhat ironically, that students from disadvantaged backgrounds, notably in social class and racial terms, were more likely than their more privileged peers to benefit from such schooling arrangements. Recent studies by Datnow *et al.* (2001), Salomone (1999), and by contributors to Datnow and Hubbard (2002), including an Australian study by Ainley and Daly (2002), are reawakening interest in these matters in the USA and beyond.

Spielhofer *et al.* (2002) investigated performance differences between students attending single-sex and coeducational schools, using a national data set made available by Government. This national value-added data set (NVAD) linked Key Stage 2 primary school students' results for 1996 with their General Certificate of Secondary Education (GCSE) results in 2001. This carefully controlled study challenged many of the findings from earlier studies.

contrary to most of the evidence in the previous literature our analysis found that, even after controlling for prior achievement and other background factors, girls in girls' comprehensive schools achieved better results than their peers in mixed schools for almost all the measured outcomes. The measured differences were particularly striking for average GCSE science score for which girls in single-sex schools could be expected to achieve over a third of a grade better than similar girls in mixed schools. For almost all outcomes students with lower prior achievement tended to make greatest progress in single-sex schools. (Spielhofer *et al.*, 2002: 47)

Such differences were not found in regard to boys of average and above average prior attainment. However, lower attaining boys subsequently performed better in single-sex comprehensive schools. The authors were careful to point out limitations of the study, including the nonavailability of information on ethnicity and on levels of parental support. Furthermore, social development was not investigated.

New legislation in the USA and amended legislation in Britain makes limited provision for new types of publicly funded schools including single-sex schools. This has given rise to a renewed debate in the USA about single-sex schooling (Datnow & Hubbard, 2002; Riordan, 2002). Although considerable research has been carried out in the UK and internationally on the relative merits of single-sex and coeducational schooling (see Arnot *et al.*, 1998), economically driven mergers of single-sex schools, especially in the voluntary sector, keep this somewhat inconclusive debate alive in the UK.

The authors consider the relevance of single-sex school experience to variation in students' mathematical achievement in a public examination taken by British students around the age of 16 years (the legal school leaving age), and to variation in attitudes to mathematics.

## Research Questions

- (1) What was the extent of variation across schools on measures of 16-year-old students' achievement in mathematics and attitude to mathematics?
- (2) What was the relationship of single-sex schooling to achievement and attitude outcome variation?

## Data Sources and Variables

Data relate to a recent survey of UK secondary schools carried out in 2001 by Durham University's Curriculum, Evaluation and Management (CEM) Centre, directed by Professor Carol Fitz-Gibbon, under its Year 11 Information System (YELLIS) Project. The CEM Centre provides value-added public examination performance data and attitudinal feedback to individual schools on students in this project, aged 15–16 years. Data on some 42,000 pupils from 294 schools have been made available to the authors for reanalysis. Although not a random sample of schools, it is considered broadly representative of English and Welsh state-funded secondary schools and, to a lesser extent, of private schools.

MATHS1: a CEM Centre maths test taken by students around age 14.

MATHS2: GCSE examination in mathematics.

MATHSATT: seven Likert-type items from questionnaire surveys (5th Year) combined to form a composite measure of attitude to maths ( $\alpha = 0.808$ ) (see Appendix 1).

GENDER: coded 1 for boys and 2 for girls.

SCH\_GENDER: coded 1 for mixed schools, 2 for girls' and 3 for boys' schools.

FATHJOB: coded 1 for manual and 2 for nonmanual occupations (father's job).

YELLIS: a CEM Centre measure of developed ability derived from a test taken by students at the start of their fourth year in secondary school.

## Methods

Methodologically, use is made of a multilevel modelling design. Multilevel modelling of hierarchical social data is an advanced form of regression analysis now widely used to provide estimates of school and pupil level variances (Aitkin & Longford, 1986; Bryk & Raudenbush, 1992; Fitz-Gibbon, 1996; Goldstein, 1995; Raudenbush & Willms, 1995; Teddlie & Reynolds, 2000).

All continuous variable scores were standardised to have a zero mean and a standard deviation of 1. Missing responses were dealt with through the substitution of school mean scores for those items, as the focus of this study was on school differences.

Technically, the data were analysed using the MLwiN software program designed by Goldstein and associates at London University's Institute of Education (Goldstein *et al.*, 1998).

## Preliminary Findings: Achievement

In terms of the null model (Model I), about 29% of the variation on the mathematics achievement measure was estimated to be at the school level, a considerable amount and somewhat higher than expected from previous UK studies (Daly, 1996). However, the bulk of the variation on maths achievement related to the student level at 71% (Table 1, Model I).

In regression coefficient terms (Table 1, Model II), regarding maths achievement, boys appeared to have a very small net advantage over girls – just 1.5% of a standard deviation, although statistically significant ( $p < 0.05$ ), hardly substantively so. By far the strongest predictor of achievement in maths at age 16 was achievement in maths at age 14, estimated at 0.696 units of a standard deviation (SD). The influence of father's job was estimated at 0.064 SD units, and a measure of academic climate, a mean score on a CEM Centre ability measure (YELLIS), amounted to 0.215 SD units. Attendance at a girls' school amounted to an advantage of 0.099 SD units compared to a disadvantage of 0.113 SD units for attendance at a boys' school, in comparison to attendance at a mixed school (the reference category).

Overall, this advantage for girls at girls' schools, about 10% of a standard deviation, has to be seen against an 11% disadvantage as far as attendance at boys' schools was concerned and would hardly carry much weight against a cost effectiveness argument favouring mixed schools, in policy terms. Perhaps the negative impact of attendance at a boys' school is more surprising given the current concerns about boys' school performance in UK schools (Epstein *et al.*, 1998). The number of boys' schools in the study, however, was too small ( $n = 9$ ) to support critical comment adequately, compared to the number of girls' schools ( $n = 32$ ). The full model explained 87% of the school level variance and 60% of the pupil level variance. Adding school gender to the model increased by less than half of one percent the proportion of variance already 'explained' at the school level and had no apparent influence on the pupil level variance estimate.

## Preliminary Findings: Attitudes to Mathematics

In contrast to the achievement estimates, only about 5% of the attitudinal variance was at the school level (Model I) with 95% at the pupil level, in line with previous work by the authors (Daly & Defty, 2002). In regression coefficient terms (Model II), girls responded less favourably than boys, on average, in the region of one quarter of a standard deviation. Perhaps surprisingly, this difference was not substantively reflected in the achievement differences between boys and girls. Ability was not strongly related to attitude to mathematics in line with a previous Centre study of pupils' attitude to science (Daly & Defty, 2001). Pupils from nonmanual backgrounds had more positive attitudes to mathematics but these were not large differences when the influence of other variables in the model was considered, at 5% of a standard deviation. Being in a girls' school represented an average advantage of 10% of a standard deviation over being in a mixed school, in line with the estimated performance advantage ( $p < 0.05$ ). Being in a boys' school did not significantly increase the likelihood of more positive

**Table 1** Parameter estimates: Models I and II

<i>Explanatory variables</i>	<i>Model I</i>		<i>Model II</i>	
	<i>Attitude to maths</i>	<i>Achievement in maths</i>	<i>Attitude to maths</i>	<i>Achievement in maths</i>
Fixed				
Intercept	0.008 (0.014)	0.000 (0.033)	0.312 (0.027)	-0.058 (0.019)
Gender (girls)			-0.259 (0.013)	-0.014 (0.007)
SES (nonmanual)			0.050 (0.010)	0.064 (0.007)
Developed ability			0.070 (0.006)	
Achievement in maths (time I)				0.696 (0.008)
School composition				
Mean ability			-0.100 (0.029)	0.215 (0.024)
Girls' school			0.102 (0.051)	0.099 (0.039)
Boys' school			0.030 (0.079)	-0.113 (0.070)
Random				
School level variance				
Intercept	0.053 (0.005)	0.288 (0.025)	0.052 (0.010)	0.037 (0.007)
Gender			0.013 (0.003)	0.003 (0.001)
SES (nonmanual)				0.002 (0.001)
Achievement in maths (time I)				0.014 (0.001)
Pupil level variance				
Intercept	0.950 (0.007)	0.710 (0.006)	0.918 (0.006)	0.310 (0.002)
School <i>n</i>	294	275	294	275
Pupil <i>n</i>	42,823	37,391	40,730	37,376

attitudinal responses to mathematics. The full model (Model II), including school gender, only explained a very small proportion of the pupil-level variance, about 3%, and did not contribute to any reduction in the school level variance.

## Concluding Remarks

Apart from being preliminary, there are a number of reasons why caution must be exercised in regard to these findings. Although the use of a multilevel modelling approach represents an important advance in statistical analysis, it is still a form of regression. The relationships reported here are not, therefore, established causal relationships.

The data set made available to the researchers by the CEM Centre did not come from a random sample of schools. However it is considered broadly representative. The sample has been compared with a nationally representative subset of that cohort (based on the school level figure of % 5 A\*-C grades, as this is the best nationally produced statistic readily available to the authors) and the results show a similar pattern. In other words, the distribution of Yellis Test Scores for the whole Yellis cohort is almost identical to the distribution of Yellis Test Scores for the nationally representative sample of that Yellis cohort.

The sample is a little undersubscribed with the independent schools, but does contain a very wide range of ability levels, from the schools at the top of any raw performance tables to the schools at the bottom of any raw performance tables. Moreover, boys' schools are under-represented.

Furthermore, data were not available on possible grammar school or faith school membership. However, by using a measure of school mean ability (in the multilevel analysis) taken two years before students sat GCSE examinations, an attempt was made to allow for further possible school intake differences.

This study offers qualified support for the conclusions drawn by Spielhofer *et al.* (2002) from their more detailed investigation of the impact of single-sex schooling on students' examination performance at the end of the period of statutory schooling.

In the study reported here, students' attitudes to mathematics represent an additional consideration. Attitudinal benefits associated with attendance at girls' schools were found but, as in the case of achievement in mathematics, the average attitudinal benefit was modest at around 10% of a standard deviation. Boys' attitudes to mathematics were not improved by attendance at boys' schools.

The Spielhofer *et al.* (2002) study also reported a modest advantage for the mathematics performance of girls in girls' schools amounting to, on average, one third of one grade on an eight-grade scale. A similar estimate was reported for average GCSE science score.

Estimate limitations apart, economically driven policy makers are unlikely to be swayed by such apparently small disparities. Perhaps they offer some support for Gill's (1993) exhortation to widen the terms of this debate in order to address more fundamental school reforms, a view comparable to that later expressed by Mcgee Bailey (1996). Changes in curricula, pedagogy and evaluation come to mind here.



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**Appendix 1: ‘Attitude to Maths’ Items**

- I find it hard to get down to work in Maths (*reverse coded*)
- I look forward to Maths lessons
- I like doing work in Maths
- I think a lot about Maths, even in my spare time
- I generally find Maths lessons rather easy
- I am frequently lost and confused in Maths lessons (*reverse coded*)
- Homework helps me to make progress in Maths

**Appendix 2: Correlation Matrix**

<i>Correlations</i>	<i>Gender</i>	<i>Maths (time 2)</i>	<i>Father’s job</i>	<i>Maths (time 1)</i>	<i>Attitude to maths</i>
Gender	1.0000				
Maths (time 2)	0.0427	1.0000			
Father’s job	0.0037	0.2184	1.0000		
Maths (time 1)	0.0241	0.7854	0.1883	1.0000	
Attitude to maths	-0.1200	0.2323	0.0404	0.1512	1.000